3. Optional Capabilities

Candidate ACMs may have more capabilities than the minimum required. These *optional capabilities* can be approved for use with the ACM for compliance purposes. Optional capabilities may not have specific capability tests in Chapter 5. Applicants wishing to receive approval for optional capabilities shall document the capability as required in this chapter and be prepared to defend the technical accuracy of any optional modeling capabilities during the ACM approval process.

The Commission does not require an ACM to incorporate optional capabilities, accept inputs for optional capabilities (except for *optional compliance capabilities*), or use optional capabilities procedures in order to become certified. If an ACM offers optional capabilities to the user, the specific capabilities shall be certified by the Commission and the ACM shall meet all special conditions, conform to all required calculation procedures, and pass certification tests (when applicable). The special conditions may include the ability to accept special input and produce special output. The assumptions for the optional capabilities shall be included in the vendor's submittal for optional capabilities as described later in this chapter. For the purpose of compliance, the use of any optional capability is considered an exceptional condition requiring special reporting on the certificate of compliance.

Optional capabilities and any non-required ACM inputs that modify ACM results in such a way that can result in the ACM failing to meet the approval criteria for any test in Chapter 5 are specifically prohibited, unless their use has been approved by the Commission as an optional capability. This is especially true for inputs and capabilities that cannot be modeled using the reference computer program. This does not mean that ACMs may not differ in their inputs. For example, one ACM may accept wall heat capacity as an input, while another may use volume, density, and specific heat of the component wall materials to calculate the heat capacity, while another still may assume a heat capacity as a function of wall type. But no ACM may have an input, for example, for mass of phase change material in the wall and material phase change temperature without specific prior written approval of that capability and its associated inputs, outputs, and internal defaults and restrictions.

If any optional capability is modeled, the option shall be specified on the appropriate compliance form which is automatically generated by the ACM. Additionally, any optional capability used in compliance shall be listed on the Certificate of Compliance as an exceptional condition.

The ACM approval application (see ACM Appendix NA) shall list and describe (or reference the description in the ACM User's Manual) all optional capabilities which are certified for compliance.

3.1 Alternations and Additions

The following optional alternations and additions capabilities may be allowed by nonresidential ACMs. There are specific output requirements for these options which are described in this Section and Section 2.2 Compliance Documentation.

3.1.1 Additions & Alterations

If the ACM is approved for the optional capabilities of alterations or automated calculation of Addition plus Existing Building, the ACM shall produce approved additional forms for existing building components and systems in accordance with the procedures described in Section 2.2 Compliance Documentation.

The Addition plus Existing Building calculation may also be performed by performing two separate runs. The first run is used to determine the budget for the existing building prior to the addition or alterations and the budget for a standard building similar to the existing building. These budgets are taken from the output for the proposed and standard building energy consumption using either the diagnostic output (if the existing building does not comply) or information from the PERF-1. The addition is modeled separately in the second run to determine the target budget for the addition space from the budget for the standard building for the addition. The budgets for these spaces are combined to determine a target budget for the combination of the two

spaces. Budgets given in energy use per square foot per year are area weighted while budgets given in energy use per year for the total area can be added together.

The altered existing building plus the addition can then be modeled and the proposed building budget from that run shall be less than the combined budget for the spaces above to get compliance.

When the addition is modeled separately and the existing HVAC system is to be expanded to serve both existing and new spaces, the HVAC system for the addition shall be modeled as a separate HVAC system of the same type as the existing HVAC system with similar efficiency characteristics (EER, COP, FPI, etc.)

3.1.2 Alteration or Addition Plus Altered Existing

ACMs that allow automated analysis of alterations of an existing building or an addition in conjunction with an existing building with alterations shall perform compliance analysis of additions and alterations according to Section 149 of the Standards. This procedure also requires special and specific input and reporting procedures that complement the reporting requirements for a new building alone.

ACMs may use a two pass compliance procedure for an Addition plus Existing Building analysis. This technique requires the modeling of two different proposed designs with the ACM: (1) existing building and (2) the altered existing building combined with the proposed addition.

3.1.3 Duct Sealing in Additions and Alterations

Section 149(a)1 establishes prescriptive requirements for duct sealing in additions and Sections 149(b)1.C. and 149(b)1.D. establish prescriptive requirements for duct sealing and duct insulation for installation of new and replacement duct systems and duct sealing for installation of new and replacement space conditioning equipment. Table NG-2 provides Duct Leakage Factors for modeling of sealed and tested new duct systems, sealed and tested duct systems in existing buildings, and untested duct systems. Appendix NG provides procedures for duct leakage testing and Table NG-3 provides duct leakage tests and leakage criteria for sealed and tested new duct systems and sealed and tested existing duct systems. These requirements, factors, procedures, tests and criteria apply to performance compliance for duct sealing in Additions and Alterations. The following table specifies the Proposed Design and Standard Design for Additions and Alterations.

Condition	*Proposed Design*	*Standard Design*
Additions Served by Entirely New Duct Systems	The Proposed Design shall be either sealed and tested new duct systems or untested duct systems.	The Standard Design shall be sealed and tested new duct systems.
Additions Served by Extensions of Existing Duct Systems	The Proposed Design shall be either 1) sealed and tested new duct systems, if the total combined existing plus new duct system meets the leakage requirements for tested and sealed new duct systems; 2) sealed and tested duct systems in existing buildings, if the total combined existing plus new duct system meets the leakage requirements for tested and sealed duct systems in existing buildings; or 3) untested duct systems.	The Standard Design shall be sealed and tested duct systems in existing buildings.

Condition	Proposed Design	Standard Design
Alterations with Prescriptive Duct Sealing Requirements when Entirely New Duct Systems are Installed	The Proposed Design shall be either 1) sealed and tested new duct systems; or 2) untested duct systems.	The Standard Design shall be sealed and tested new duct systems.
Alterations with Prescriptive Duct Sealing Requirements when Existing Duct Systems are extended or replaced or when new or replacement air conditioners are installed	The Proposed Design shall be either 1) sealed and tested new duct systems, if the total combined existing plus new duct system meets the leakage requirements for tested and sealed new duct systems; 2) sealed and tested duct systems in existing buildings, if the total combined existing plus new duct system meets the leakage requirements for tested and sealed existing duct systems; or 3) untested duct systems.	The Standard Design shall be sealed and tested duct systems in existing buildings.
Alterations for which Prescriptive Duct Sealing Requirements do not apply	The Proposed Design shall be either 1) sealed and tested new duct systems, if the new duct system or the total combined existing plus new duct system meets the leakage requirements for tested and sealed new duct systems; 2) sealed and tested duct systems in existing buildings, if the total combined existing plus new duct system meets the leakage requirements for tested and sealed existing duct systems; or 3) untested duct systems.	The Standard Design shall be untested duct systems.

3.1.4 Output Reports for Existing Buildings

There are special output requirements for existing building components and characteristics that are passed directly to the standard design and compared against themselves in the custom budget process. In general, these shall be reported on separate forms and in a distinctly different typestyle from new or altered building components and characteristics in output reports. To accommodate all printers this is done by using lowercase and UPPERCASE output to differentiate these inputs. See Section 2.2 Compliance Documentation for more details.

To accommodate the optional capabilities of partial compliance and modeling additions with the existing building and alterations and deter circumvention of the standards, all ACMs SHALL report all new or altered user-entered building components and descriptive information completely in UPPERCASE TYPE. ACMs with the capabilities for partial compliance, modeling additions with the existing building or modeling alterations in an existing building SHALL report all information on existing, previously-approved building components that are not altered in lowercase type. This is to insure that the local enforcement agency can readily determine the use of existing building components that do not have to meet the requirements of the building energy efficiency standards and distinguish these modeled components from those that are new or have been altered.

3.2 Building Occupancy

3.2.1 Alternate Occupancy Selection Lists

The user of an ACM shall select an occupancy type from certain allowed tables. ACMs that do not have separate selection lists for ventilation occupancy assumptions and all other occupancy assumptions shall allow the user to select from the occupancies and sub-occupancies listed in Table N2-2 and Table N2-3 or to select from an officially approved alternative sub-occupancy list that maps into those occupancies. ACMs that have separate occupancy selection lists for ventilation assumptions and other assumptions shall use the occupancy selections given in tables in the building energy efficiency standards or approved alternative lists of occupancies. The occupancies listed in Table 121-A in the Standards shall be used for ventilation occupancy selections and the occupancies listed in Table 146-C in the Standards shall be used for selecting the remaining occupancy assumptions. Alternatively specific occupancy selection lists approved by the Commission that map into Tables 121-A or 146-C may be used.

A building consists of one or more occupancy types. ACMs may not combine different occupancy types. Tables N2-2 and N2-3 describe all of the schedules and full load assumptions for occupants, lighting, infiltration, receptacle loads and ventilation. Full load assumptions are used for both the proposed design and the standard design compliance simulations.

3.2.2 Lighting Controls

Description:	Lighting controls have specific lighting power adjustment factors as listed in Table 146-A of the standards and any ACM may use these lighting control credits (subject to the requirements and specifications in Section 119 of the standards) just as they would with prescriptive compliance, except for the performance approach, credit cannot be taken for lighting controls that are required by other provisions of the standards, especially Sections 119 and 131. For lighting controls required by 131(c)2 (either a multi-level automatic daylighting control or an astronomical multi-level time switch control), no credit is permitted for the minimally compliant control (astronomical multi-level time switch control), which is modeled in both the proposed building and the standard building. However, if automatic multi-level daylighting controls are used, the proposed building benefits from an additional lighting power reduction. The ACM Compliance Documentation shall describe how to determine which controls can be used for credit subject to this restriction. ACMs may explicitly model any of the lighting controls listed in Table 146-A of the standards. The ACM shall require the user to input: 1) the area occupancy to which lighting controls are being applied; and, 2) the lighting control strategy or strategies being used. ACMs allow input for lighting control only when an area occupancy type has been input for the zone. ACMs with this optional capability shall automatically generate a LTG-3, Lighting Controls Credit Worksheet, as part of the compliance documentation.
DOE Keyword:	LIGHTING-W/SQFT
Input Type:	Required
Tradeoffs:	Yes
Modeling Rules for Proposed Design:	The ACM shall model lighting controls in the proposed design as input by the user according to plans and specifications for the building.
Modeling Rules for Standard Design (New & Altered Existing):	The standard design shall model only the lighting controls that are required by other provisions of the standards

Modeling Rules for Standard Design (Existing Unchanged):	The standard design shall model lighting controls that are installed in the existing building.

3.2.3 Light Heat to Zone

Description:	The reference method assumes that 100% of the heat due to lighting goes to the zone where the lighting is located. An optional capability may vary the lighting heat to the zone from 70%-100% and, consequently, the lighting heat to the return air from 0% to 30%, as a function of the type of lighting fixtures used in the zone. In the absence of persuasive evidence to the contrary, direct user entry of the allocation of lighting heat to the zone and the return air is considered an enforcement problem and is considered grounds for disqualification of an ACM from the approval process.
DOE Keyword:	LIGHT-TO-SPACE
Input Type:	Required
Tradeoffs:	Neutral
Modeling Rules for Proposed Design:	ACMs shall model the lighting heat-to-space and lighting heat-to-return air bases on the type of lighting fixtures used in the space as shown in the construction documents.
Modeling Rules for Standard Design (New & Altered Existing):	The standard design shall use the same lighting heat-to-space and lighting heat-to-return air as the proposed design.
Modeling Rules for Standard Design (Existing Unchanged):	The standard design shall model lighting heat-to-space and lighting heat-to-return air based on the lighting fixtures installed in the existing building.

3.3 HVAC Systems and Plants

This section describes the optional HVAC systems and plant capabilities. The ACM shall use the performance curves in the DOE-2 Supplement (Version 2.1E). If the described optional capability is not a capability of the Commission's reference computer program, vendors shall include the required performance data for that capability. The assumptions in this section may be different than the corresponding assumptions specified in the Required Systems and Plant Capabilities, in order to model optional capabilities accurately.

Standard design requirements are labeled as applicable to one of the following options:

- Existing unchanged
- Altered existing
- New
- All

with the default condition for these four specified conditions being “All.” An ACM without the optional capability of analyzing additions or alterations shall classify and report all surfaces as “All.”

3.3.1 Absorption Cooling Equipment

Description:	ACMs may model heat operated (absorption) cooling equipment with the following

features:

- *One-stage absorption.* Heat operated water chiller. With this option, the ACM shall account for absorber and refrigerant pump energy and purge cycle.
- *Two-stage absorption.* Heat operated water chiller using two-stage or double effect concentrator. With this option, the ACM shall account for absorber and refrigerant pump energy and purge cycle.
- *Economizer.* For absorption chiller, absorber solution flow to the concentrator is modulated as a function of load.
- *Steam fired.* Absorption chiller uses steam as the heat source.
- *Hot water fired.* Absorption chiller uses hot water as the heat source.
- *Direct fired.* Absorption chiller uses fossil fuel as heat source.

DOE Keyword: PLANT-EQUIPMENT
ABSOR1-CHLR
ABSOR2-CHLR
ABSORG-CHLR

Input Type: Required

Tradeoffs: Yes

Modeling Rules for Proposed Design: The ACM shall model absorption equipment in the proposed design as input by the user according to the plans and specifications for the building. The ACM shall use performance relationships according to the DOE 2.1 default equipment curves or the user shall enter manufacturer's performance data for gas absorption chillers as described in Section 2.5.3.16 and the ACM shall use the performance curves derived from the user-entered data.

Modeling Rules for Standard Design (New): ACMs shall determine the standard design according to the requirements of the Required Systems and Plant Capabilities and **Error! Reference source not found.**.

Modeling Rules for Standard Design (Existing Unchanged & Altered Existing): ACMs shall model the existing system as it occurs in the existing building. If the permit involves alterations, ACMs shall model the system before alterations.

3.3.2 Gas-Engine Driven Chillers and Heat Pumps

Description: ACMs may model engine driven cooling equipment with the following features:

- *Engine Driven Chiller.* Fossil fuel engine driven, compressor water chiller.
- *Engine Driven Heat Pump.* Fossil fuel engine driven heat pump.
- *Air Cooled Condenser.* Chiller or Heat Pump uses water to cool condenser.
- *Water Cooled Condenser.* Chiller or Heat Pump uses water to cool condenser.
- *Engine Waste Heat Recovery.* Waste heat is recovered from engine coolant for reuse in a space heating application.
- *Exhaust Heat Recovery.* Heat is extracted from engine exhaust gases for reuse in a space heating application (see Section 3.3.4).

DOE Keyword: PLANT-EQUIPMENT
ENG-CHLR
or

	HEAT-SOURCE GAS-HEAT-PUMP
Input Type:	Required
Tradeoffs:	Yes
Modeling Rules for Proposed Design:	The ACM shall model gas engine driven equipment in the proposed design as input by the user according to the plans and specifications for the building. The ACM shall use performance relationships as established by the DOE 2.1 default equipment curves.
Modeling Rules for Reference Standard Design (New):	ACMs shall determine the standard design according to the requirements of the Required Systems and Plant Capabilities and **Error! Reference source not found.**.
Modeling Rules for Reference Standard Design (Existing Unchanged & Altered Existing):	ACMs shall model the existing system as it occurs in the existing building. If the permit involves alterations, ACMs shall model the system before alterations.

3.3.3 Chiller Heat Recovery

Description:	ACMs may model double bundle condensers on cooling equipment for heat recovery.
DOE Keyword:	N/A
Input Type:	Required
Tradeoffs:	Yes
Modeling Rules for Proposed Design:	The ACM shall model heating equipment options in the proposed design as input by the user according to the plans and specifications for the building.
Modeling Rules for Standard Design (New):	The ACM shall model the standard design according to the requirements of the Required Systems and Plant Capabilities.
Modeling Rules for Standard Design (Existing Unchanged & Altered Existing):	ACMs shall model the existing system as it occurs in the existing building. If the permit involves alterations, ACMs shall model the system before alterations.

3.3.4 Exhaust Heat Recovery

Description: ACMs may model the following methods of heat recovery as input by the user.

- *Heat pipe.* Heat recovered from exhaust air is transferred to supply air via passive heat transfer coil (typically using refrigerant as the medium). No mechanical energy is required for heat recovery. With this option, the ACM shall account for additional coil pressure drops.
- *Hydronic loop.* Heat recovered from exhaust air is transferred to supply air via hydronic system including coils in each air stream and water circulation system (run-around system). With this option, the ACM shall account for circulating pump energy and accounts for additional coil pressure drops.
- *Heat wheel sensible.* Heat recovered from exhaust air is transferred to supply air via mechanically rotating heat wheel. The wheel may transfer sensible heat. With this option, the ACM shall account for heat wheel motor energy and

accounts for additional coil pressure drops.

DOE Keyword:	RECOVERY-EFF SUPPLY-1 thru SUPPLY-5 DEMAND-1 thru DEMAND-5
Input Type:	Required
Tradeoffs:	Yes
Modeling Rules for Proposed Design:	The ACM shall model heat recovery options in the proposed design as input by the user according to the plans and specifications for the building.
Modeling Rules for Standard Design (New):	The ACM shall model the standard design according to the requirements of the Required Systems and Plant Capabilities.
Modeling Rules for Standard Design (Existing Unchanged & Altered Existing):	ACMs shall model the existing system as it occurs in the existing building. If the permit involves alterations, ACMs shall model the system before alterations.

3.3.5 Optional System Types

Description

ACMs may model HVAC system types not included in the list of 5 minimum standard and proposed system types. Specifically, ACMs may model the following proposed system types:

- **System 6:** Hydronic Heat Pump. Zone cooling/heating capability may be provided by a zonal hydronic heat pump connected to a central water heat source/heat rejection loop, shared by other zonal hydronic heat pumps.
- **System 7:** Single Fan/Dual Duct. A single fan blows supply air through the heating and cooling coils and into the hot and cold supply ducts, with either a constant or variable volume fan. Zone terminal units mix hot and cold supply air streams to meet zone loads.
- **System 8:** Dual Fan/Dual Duct. Two separate central fan systems, one for heating and one for cooling, using either constant or variable fans, distribute air to the building. Zone terminal units mix hot and cold supply air streams to meet zone loads. If this system is included, the ACM shall also simulate heating supply air reset, described below.
- **System 9:** Direct and Indirect Evaporative Cooling. Evaporative cooling may be modeled as the only cooling system or as a precooler for another cooling system. The systems may utilize direct evaporative cooling only; indirect evaporative cooling only; indirect/direct evaporative cooling; or evaporatively precooled condensers. Direct or indirect evaporative precooling of supply air may also be modeled but no tests or specifications are defined for these options. Users shall be able to specify evaporative cooler fan capacity and brake horsepower (bhp), water pump capacity and brake horsepower (bhp), and whether or not the evaporative cooler can operates in conjunction with another cooling system. When evaporative cooling systems are modeled, default measures of direct and indirect (where applicable) cooling efficiencies shall be supplied. Subject to Commission approval, the user may be allowed to override these defaults.
- **System 10:** Underfloor Air Distribution Systems (UFAD). A central system provides air (typically 60°F to 68°F) to an underfloor plenum. It is distributed to the space using either passive or active grilles (cooling), across reheat coils or through fan-powered boxes (typically variable speed with reheat coils).

Although this system uses warmer supply air temperatures it usually has a similar airflow to a conventional overhead system as it provides displacement of some of the thermal loads. The modeling software shall make accommodations for the user to specify the following system features: assignment of a percentage of the lighting, miscellaneous equipment and occupant loads to the return air plenum; application of variable speed fan powered boxes with a minimum airflow setting; application of a demand based pressure reset of the airflow; application of supply temperature reset by either demand or outdoor dry-bulb temperature; and assignment of low system static pressures.

- **System 11:** Single Zone Variable Air Volume Systems.

  Minimum turn down for airflow shall be no lower than that certified by the manufacturer as required to protect the cooling coil from freezing.

Perimeter Systems. Independent HVAC systems (typically heating only) which serve perimeter zones in addition to a primary system (typically cooling only). Perimeter systems differ from zone terminal systems in that they are independent: They do not connect to the primary system but supply heating/cooling through separate air outlets or heat transfer surfaces. There are two common types of perimeter systems.

- **System 12:** Convective/radiant. Zone perimeter system may be a convective or radiant system, such as baseboard or radiant ceiling panels.
- **System 13:** Constant volume system. Zone perimeter system provides heating/cooling by constant air volume supply to each zone served. System may or may not have outside air supply capability.

Perimeter systems may incorporate the following features (NOTE that perimeter systems may be specified as serving the same zone(s) as any of Systems 1 through 10):

- *Master zone.* Used when the perimeter system heating/cooling supply is controlled to satisfy the thermostat of a given zone.
- *Multiple zones.* Used when the perimeter system serves more than one zone of the primary system. (This allows modeling of "fighting" between the primary and perimeter system.)
- *Electric.* Used when the perimeter system heating is electric resistance.
- *Hydronic.* Used when the perimeter system cooling/heating coil is served by a central hydronic system.
- DX. Used when the perimeter system cooling is provided by direct expansion refrigerant coils served by a heat pump or other compression system (see PLANT equipment.)

DOE Keyword:	SYSTEM-TYPE
Input Type:	Required
Tradeoffs:	Yes
Modeling Rules for Proposed Design:	Optional proposed systems shall be modeled as input by the user, according to the plans and specifications for the building, subject to all of the restrictions specified in the Required Systems and Plant Capabilities.
Modeling Rules for Standard Design (New):	Standard system types and applicable system parameters are chosen according to **Error! Reference source not found.**. The air flow and supply air temperature for the standard design will be optimally controlled in the reference method. All efficiency descriptors shall be determined according to the requirements of the

Required Systems and Plant Capabilities.

Modeling Rules for Standard Design (Existing Unchanged & Altered Existing): ACMs shall model the existing system as it occurs in the existing building using DOE-2 default performance curves. If the permit involves alterations, ACMs shall model the system before alterations.

3.3.6 Combined Hydronic Systems

Nonresidential Buildings

Combined hydronic water heating systems for nonresidential buildings may be modeled as an optional capability. Vendor-proposed prescribed assumptions for this method are crucial. All user-defined inputs shall be enforceable. Variables which are difficult to plan and field verify should be incorporated as prescribed inputs. The residential water heating calculation methodology is a useful example for compliance-based combined hydronic heating system modeling.

High-Rise Residential Buildings

Combined hydronic water heating systems evaluation for high-rise residential buildings should be evaluated in a manner consistent with the low-rise residential combined hydronic system methodology. A vendor-proposed optional capability should incorporate the majority of efficiency measures evaluated by the low-rise residential method and should be reasonably consistent with those procedures, especially near the transition between low-rise and high-rise buildings. Inputs and analysis of wood stoves and wood-fired boiler are not required (in fact discouraged) to be included as part of the optional capability.

3.3.7 Alternate Equipment Performance Data

Description

ACMs may model equipment according to factory supplied performance data. The following performance relationships may be modeled:

All Packaged Cooling Equipment

See Chapter 2.

Packaged VAV Cooling Equipment Only

- Capacity as a function of supply air quantity
- Cooling electrical efficiency as a function of supply air quantity
- Sensible cooling capacity as a function of supply air quantity

Water Chillers

- Capacity as a function of exiting chilled water and entering condenser water temperatures
- Cooling electrical efficiency as a function of exiting chilled water and entering condenser temperatures

Furnaces

- Fossil fuel furnace efficiency

Heat Pumps

- See Chapter 2.

Boilers

- Fossil fuel boiler efficiency

DOE Keyword:	COOLING-EIR HEATING-HIR FURNACE-HIR HW-BOILER-HIR BOILER-EIR BOILER-HIR
Input Type:	Required
Tradeoffs:	Yes
Modeling Rules for Proposed Design:	ACMs shall model performance of proposed systems and plant equipment, except for fans, using DOE-2 default performance curves for the equipment specified in the construction documents for the building.
Low Value:	Minimum efficiency requirement
Modeling Rules for Standard Design (New):	ACMs shall model performance of all systems and plant equipment, except for fans, according to requirements of the Required Systems and Plant Capabilities, and the default performance curves listed in the DOE 2.1E supplement.
Modeling Rules for Standard Design (Existing Unchanged & Altered Existing):	ACMs shall model the existing system as it occurs in the existing building using the system's actual efficiencies according to requirements of the Required Systems and Plant Capabilities and DOE-2 default performance curves. If the permit involves alterations, ACMs shall model the system before alterations.

3.3.8 Cooling Towers Types

Description: ACMs may model several options for cooling tower operation which may be specified at the user's option. These options are described below:

- *Closed circuit.* Condenser water is cooled indirectly by a heat exchanger which is evaporatively cooled (fluid cooler). With this option, the ACM shall account for spray pump energy. If the ACM has this capability, it shall require the user to specify if the cooling tower uses an open or closed circuit.
- *Axial fan.* An axial fan provides ambient air flow across tower fill or closed tower heat exchanger.
- *Natural draft.* Ambient air flow across tower fill is natural draft (not mechanically driven) as defined by user input tower dimensional data and draft factor.
- *Discharge dampers.* Tower (condenser) capacity is controlled by modulating fan discharge dampers.
- *Bypass.* Tower leaving water temperature is controlled by bypassing tower return water around tower to the supply line, thereby cooling only a portion of the water flow.
- *Variable speed drive.* Tower (condenser) capacity is controlled by varying fan motor speed.

DOE Keyword:	TWR-CAP-CTRL TWR-MIN-FAN-SPEED FLUID-BYPASS
Input Type:	Required
Tradeoffs:	Yes
Modeling Rules for Proposed Design:	The ACM shall model all optional cooling tower features as input by the user according to the construction documents for the building.

Modeling Rules for Standard Design (New):	The ACM shall model the standard design according to the requirements of the Required Systems and Plant Capabilities.
Modeling Rules for Standard Design (Existing Unchanged & Altered Existing):	ACMs shall model the existing system as it occurs in the existing building using the system's actual efficiencies. If the permit involves alterations, ACMs shall model the system before alterations.

3.3.9 Pump Controls

Description: ACMs may model several optional pump design, operation and control strategies which may be specified at the user's option. These options are described below:

- *Variable flow.* Used when the variable flow, constant temperature system flow rate varies as a function of load.
- *Riding curve.* Pump(s) ride characteristic performance curve as a function of head pressure. Head pressure will vary depending on the water demands of cooling and heating coils and the amount of water bypassing different zones.
- *Two-speed/stages.* Used when the pumps are staged, or pump has two-speed motor, to maintain pressure requirements. Pump(s) ride characteristic curve between stages.

DOE Keyword:
TWR-PUMP-HEAD
TWR-IMPELLER-EFF
TWR-MOTOR-EFF
CIRC-IMPELLER-EFF
CIRC-MOTOR-EFF
CIRC-HEAD
CIRC-PUMP-TYPE
DHW-PUMP-ELE

Input Type:	Required
Tradeoffs:	Yes
Modeling Rules for Proposed Design:	ACMs shall model optional features of proposed design pumping systems as input by the user according to plans and specifications for the building.
Modeling Rules for Standard Design (New):	The ACM shall model the standard design according to the requirements of the Required Systems and Plant Capabilities.
Modeling Rules for Standard Design (Existing Unchanged & Altered Existing):	ACMs shall model the existing system as it occurs in the existing building. If the permit involves alterations, ACMs shall model the system before alterations.

3.3.10 Air Foil Centrifugal Fan with Discharge Dampers

Description: The ACM may model the following optional types of fan volume control, as input by the user. Default fan curves are given in terms of DOE-2 curve-fit instructions.

Air foil centrifugal fan with discharge dampers (ride fan curve). Fan volume is controlled by a controllable damper mounted at the fan discharge, or the fan "rides" its characteristic fan curve against varying system pressure.

AF-FAN-W/DAMPERS = CURVE-FIT

TYPE = QUADRATIC
OUTPUT-MIN = 0.68
DATA = (1.0,1.0)
(0.9,0.95)
(0.8,0.90)
(0.7,0.86)
(0.6,0.79)
(0.5,0.71)

Vane-axial fan with variable pitched blades. Fan volume is controlled by varying blade pitch.

VANE-AXIAL-FAN = CURVE-FIT
TYPE = QUADRATIC
OUTPUT-MIN = 0.15
DATA = (1.0,1.0)
(0.9,0.78)
(0.8,0.60)
(0.7,0.48)
(0.6,0.36)
(0.5,0.27)
(0.4,0.20)
(0.3,0.23)
(0.2,0.22)

DOE Keyword:	FAN-CONTROL
Input Type:	Prescribed
Tradeoffs:	Neutral
Modeling Rules for Proposed Design:	The ACM shall model supply and return fans chosen by the user and as documented on the plans and specifications for the building for the proposed design fan system. The ACM shall use the performance data given in this manual.
Modeling Rules for Standard Design (New):	The ACM shall model the standard design according to the requirements of the Required Systems and Plant Capabilities.
Modeling Rules for Standard Design (Existing Unchanged & Altered Existing):	ACMs shall model the existing system as it occurs in the existing building. If the permit involves alterations, ACMs shall model the system before alterations.

3.3.11 Separate Control for Supply, Return and Relief Fans

Description:	ACMs may model different fan volume control strategies for supply, return and relief fans. If the ACM has this capability the user may specify a different strategy for each fan in the fan system.
DOE Keyword:	FAN-CONTROL
Input Type:	Required
Tradeoffs:	Yes
Modeling Rules for Proposed Design:	The ACM shall model fan volume controls for each proposed design fan as input by the user. If different fan volume controls are not input for supply, return and/or relief fans, the ACM shall assume all fan volume controls for the entire fan system to be the same as that specified for the supply fan.

Modeling Rules for Standard Design (New):	The ACM shall model the standard design according to the requirements of the Required Systems and Plant Capabilities.
Modeling Rules for Standard Design (Existing Unchanged & Altered Existing):	ACMs shall model the existing system as it occurs in the existing building. If the permit involves alterations, ACMs shall model the system before alterations.

3.3.12 Air Economizers Control Strategies

Description: The ACM may model the following optional economizer control strategies when specified by the user:

- *Outside air enthalpy.* Economizer cooling is enabled as long as the outside air enthalpy is less than 29 Btu/lb.
- *Variable enthalpy.* Equivalent to the Honeywell W7400 or H205 humidity biased enthalpy control using set-curve A.
- *Differential dry-bulb.* Economizer cooling is enabled as long as the return air temperature is greater than the outside air temperature.
- *Differential enthalpy.* Economizer cooling is enabled as long as the return air enthalpy is greater than the outside air enthalpy.
- *Economizer High Limit.* When a differential controller is used, a high limit, above which the economizer cannot operate, may also be added. The high limit controller can either be a dry-bulb (set at 75 degrees), an enthalpy (set at 29 Btu/lb) or a variable enthalpy controller.
- *Non-integrated, two stage operation.* The economizer operates as the first stage of cooling until the cooling load cannot be met by the economizer. At this point, the economizer closes to the minimum position and mechanical cooling is used to meet the cooling load. If this strategy is selected, an outdoor high limit of 70 ODB or 28.5 Btu/lb shall be used.

DOE Keyword:	OA-CONTROL ECONO-LIMIT-T ECONO-LOCKOUT ENTHALPY-LIMIT DRYBULB-LIMIT
Input Type:	Default
Tradeoffs:	Yes
Modeling Rules for Proposed Design:	ACMs shall limit proposed design optional economizer control strategies to those listed in this section, including set points.
Default:	No economizer
Modeling Rules for Standard Design (New):	The ACM shall model the standard design according to the requirements of the Required Systems and Plant Capabilities.
Modeling Rules for Standard Design (Existing Unchanged & Altered Existing):	ACMs shall model the existing system as it occurs in the existing building. If the permit involves alterations, ACMs shall model the system before alterations.

3.3.13 Water Side Economizers

Description

ACMs may model the following water side economizers when specified by the user:

- *Strainer cycle.* Used when cooling tower water is diverted to the main cooling coil for "free cooling" when the cooling tower leaving water temperature is low enough to meet the total building load. This type of water side economizer can only be used in place of, and cannot be used to supplement, mechanical cooling.
- *Series coil.* A cooling coil, connected to the condenser water loop ahead of the condenser, is placed in the air handler upstream of the main cooling coil. This coil is used to supplement mechanical cooling, when the cooling benefit is greater than the added pumping energy needed to circulate cooling tower water through the cooling coil.
- *Evaporator precooling (heat exchanger).* A heat exchanger is used to transfer heat from condenser water, prior to entering the condenser, and chilled water, prior to entering the evaporator, in order to precool the chilled water. If the difference between the return chilled water temperature and cooling tower leaving water temperature is large enough to provide a cooling benefit, the heat exchanger is used to supplement mechanical cooling.
- *Evaporator precooling (cooling tower).* Chilled water is circulated through a closed loop in the cooling tower before entering the evaporator. If the difference between the chilled water return temperature and outside wet-bulb temperature is large enough to provide a cooling benefit, chilled water is circulated to the cooling tower to supplement mechanical cooling.

DOE Keyword:

WS-ECONO
WS-ECONO-MIN-DT
WS-ECONO-XEFF
CONDENSER-TYPE
FLUID-VOLUME
COND-FLOW-TYPE
COND-WTR-FLOW

Input Type: Default

Tradeoffs: Yes

Modeling Rules for Proposed Design: The ACM shall model the proposed system water side economizer as input by the user, according to the plans and specifications for the building. If a strainer cycle is specified, changeover temperature from economizer to mechanical cooling shall be set at 50^{o}F.

Default: No economizer

Modeling Rules for Standard Design (New): The ACM shall model the standard design according to the requirements of the Required Systems and Plant Capabilities.

Modeling Rules for Standard Design (Existing Unchanged & Altered Existing): ACMs shall model the existing system as it occurs in the existing building. If the permit involves alterations, ACMs shall model the system before alterations.

3.3.14 Zone Terminal Controls

Description: ACMs may model the following optional features for zone terminal controls, as input by the user:

- *Constant volume.* Zone receives a constant volume of air regardless of thermostat signal.
- *Mixing hot deck/cold deck.* Zone temperature is controlled by mixing hot and cold air.
- *Induction.* Supply air induces room or return plenum air into the supply air stream.
- *Fan powered induction.* Zonal fan supplies return or room air optionally mixed with system supply air (if any).
- *Series.* Fan powered induction system where zonal fan is in series with primary system supply air. Fan runs continuously when central system is on providing constant volume to space.
- *Parallel.* Fan powered induction system where zonal fan is in parallel with primary system supply air. Primary supply is usually VAV. Fan cycles on only when heating is required.
- *Series/Parallel.* Fan powered induction system where zonal fan is in parallel with primary system supply air. Primary supply is usually VAV. Fan cycles on to maintain a minimum supply volume and when heating is required.

DOE Keyword: TERMINAL-TYPE

Input Type: Required

Tradeoffs: Yes

Modeling Rules for Proposed Design: The ACM shall model optional zone terminal control features as input by the user according to the plans and specifications for the building. If the TERMINAL-TYPE is specified as SERIES-PIU (series fan-powered induction system), the ACM shall use the following fan power:

ZONE-FAN-KW = 0.000225

Modeling Rules for Standard Design (New): The ACM shall model the standard design according to the requirements of the Required Systems and Plant Capabilities.

Modeling Rules for Standard Design (Existing Unchanged & Altered Existing): ACMs shall model the existing system as it occurs in the existing building. If the permit involves alterations, ACMs shall model the system before alterations.

3.3.15 Solar Thermal Energy

Description: The depletable energy savings associated with solar collector systems shall be analyzed by the Commission. A nonresidential ACM may be approved with the optional capabilities of built-in solar collector performance calculations. Vendors who wish to have their Nonresidential ACMs approved with either of these capabilities shall meet the requirements described in the Residential ACM manual.

DOE Keyword: N/A

Input Type: Default

Tradeoffs:	Yes
Modeling Rules for Proposed Design:	ACMs may model solar water heating as an energy source for service hot water heating only.
Default:	No renewable energy is used.
Modeling Rules for Standard Design (New):	ACMs shall not model renewable energy sources for any of the standard design energy use.
Modeling Rules for Standard Design (Existing Unchanged & Altered Existing):	ACMs shall model the existing system as it occurs in the existing building. If the permit involves alterations, ACMs shall model the system before alterations.

3.4 Vendor Defined Optional Capabilities

Vendors may propose other optional capabilities not specifically described in this manual. In the proposal for vendor specified optional capabilities, the vendor shall include:

- Theoretical background and simulation algorithms
- Testing data and validation analysis for all specified capabilities
- Standard and proposed design assumptions
- Specific documentation requirements, addressing enforceability by building department personnel

The Commission, during the certification process, may require changes to the vendors' proposed methods in order to gain consistency with other vendors' proposing similar capabilities.